From a set of measurements of a parameter the best value available is the average value. The error associated with this average value is not the average of the deviations from this average value but rather the average of these deviations divided by the square root of the number of measurements. In other words, the precision improves in proportion to the square root of the reciprocal of the number of measurements in the sample set.

C.2. Error in Free Surface Velocity Measurements

The experimental technique used to measure the free surface motion was to photographically record with a streak camera the changes in the intensity of reflected light from the tilted mirrors which were placed on the surfaces of the test samples. For this experimental technique the free surface velocity is a function of five different parameters. (See Chapter 2.) Each parameter is unknown by a certain amount. Each individual uncertainty in the five parameters contributes to the overall uncertainty in the free surface velocity. Determination of the total uncertainty is the goal of this appendix.

The free surface velocity due to the plastic I shock is given by

$$u_{fs} = \frac{u_c}{M_f} \frac{\tan \alpha}{\tan \gamma - \tan \omega} \qquad (C.3)$$

where u_{fs} is the free surface velocity due to the plastic I shock, u_c is the camera speed, α is the tilted mirror angle,

M_f is the magnification (image/object), γ is the angle of the trace, and ω is the wave tilt angle on the film. The total error in u_{fs} is given by

$$\frac{\varepsilon}{u_{fs}} = \left[\left(\frac{\varepsilon_{u_c}}{u_c} \right)^2 + \left(\frac{\varepsilon_{M_f}}{M_f} \right)^2 + \left(\frac{2\varepsilon_\alpha}{\sin 2\alpha} \right) \right. \tag{C.4}$$

$$\left. + \left(\frac{\varepsilon_\gamma}{\cos^2\gamma(\tan\gamma - \tan\omega)} \right)^2 + \left(\frac{\varepsilon_\omega}{\cos^2\omega(\tan\gamma - \tan\omega)} \right)^2 \right]^{1/2}$$

The individual errors for camera speed, magnification, mirror angle, trace angle, and wave tilt angle contain both random and systematic errors. The random errors were estimated by taking the deviations from the average of a number of measurements of each parameter. The systematic error was usually taken as equal to one-half of the smallest division of the instrument used to measure the parameter. The total error for each parameter was then found by taking the SRSS of the systematic and random errors.

C.2.1. Sources of Various Errors

The performance of accurate experiments requires knowledge of the source and magnitude of the various errors. The purpose of this subsection is to identify the sources of error in the free surface velocity measurement and to determine which are the important errors.

The error in the camera writing speed was determined from the error associated with the calibration constant (see